Space Weather Technical Forecast

Issued on Tuesday 29 October 2024 at 01:11 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: S2 Moderate Solar Radiation Storm ongoing. Further M-class flares expected with chance of X-class flares.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Moderate with peak flare M4.2 at 28/1628 UTC from AR3878 in the northeast. This is a relatively small but complex region that is now showing a small but strong delta spot on its trailer spot. There are currently eleven sunspot regions on the disc, and the most likely source of further notable flares is the congested southeast disc with a number of regions. AR3872 has a delta configuration with some ongoing slight growth, and is flanked on either side by AR3873 and AR3869. Although these two nearby spots have shown a declining trend. AR3876 in the south-centre and AR3874 in the northwest, while simpler, have both shown some slow development in the last 24 hours.

No Earth-directed CMEs were observed.

Solar Wind / Geomagnetic Activity: The anticipated X1.8 flare CME, which left the Sun on 26 Oct, arrived at L1 at 28/0414 UTC. This was followed by solar winds speeds, observed by ACE, increasing from Slightly Elevated at 400km/s to be Elevated to briefly Strong levels, peaking at 616km/s at 28/0447 UTC. Solar winds then eased to around 500km/s by the end of the period. Density was near or below average at the start of the period, but became average to above average with the arrival of the aforementioned CME, before steadily declining to below average values at present. Interplanetary Magnetic Field (IMF), Bt, was initially Weak around 6-7nT, then rose sharply to be Strong at around 23nT with the CME arrival, then eased back to the current Weak levels, near 7nT. The north-south component, Bz, was variable and weak for much of the period, but also became strong for a time with the CME arrival, varying +/-20nT, but favoured a positive (northward) orientation. Phi angle remained negative (towards the Sun). Geomagnetic activity was Unsettled to Active (Kp3-4), with a G1 Minor Storm (Kp 5) interval observed at 28/0300-0600UTC with the CME arrival.

Energetic Particles / Solar Radiation: High energy proton flux observed by GOES18 persisted at S2 Moderate Storm, with peak 364 pfu at 28/1350 UTC. High energy electron flux (greater than 2MeV) observed by GOES16 was at background. The associated 24-hour fluence was well below the Active threshold, with 1.7e6 integrated flux observed at 29/0000UTC.

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Four-Day Space Weather Forecast Summary

Solar Activity: Moderate to High activity is expected, with further M-class flares expected and a chance of isolated X-class flares.

Solar Wind / Geomagnetic Activity: There are no further CME arrivals currently expected. Ongoing CME influence is forecast to ease day 1 (29 Oct). Solar winds are expected to ease from Elevated to Background, however some influence from the fast wind of CH85 may delay this until day 2 (30 Oct). Geomagnetic activity is forecast to ease to be mainly Quiet with isolated Unsettled intervals from day 1 (29 Oct) onward.

Energetic Particles / Solar Radiation: The high energy proton flux at GOES-18 has persisted at S2 Moderate Storm with the weak CME arrival not being sufficient to cause these to drop out. A gradual decay is now expected, but likely persisting above the S1 until at least later day 1, possibly into day 2 (29-30 Aug). Any further notable flares from the regions in the southeast will bring the potential for further enhancement. The high energy electron flux is expected to be mainly Background, with the associated fluence forecast to persist below Active.

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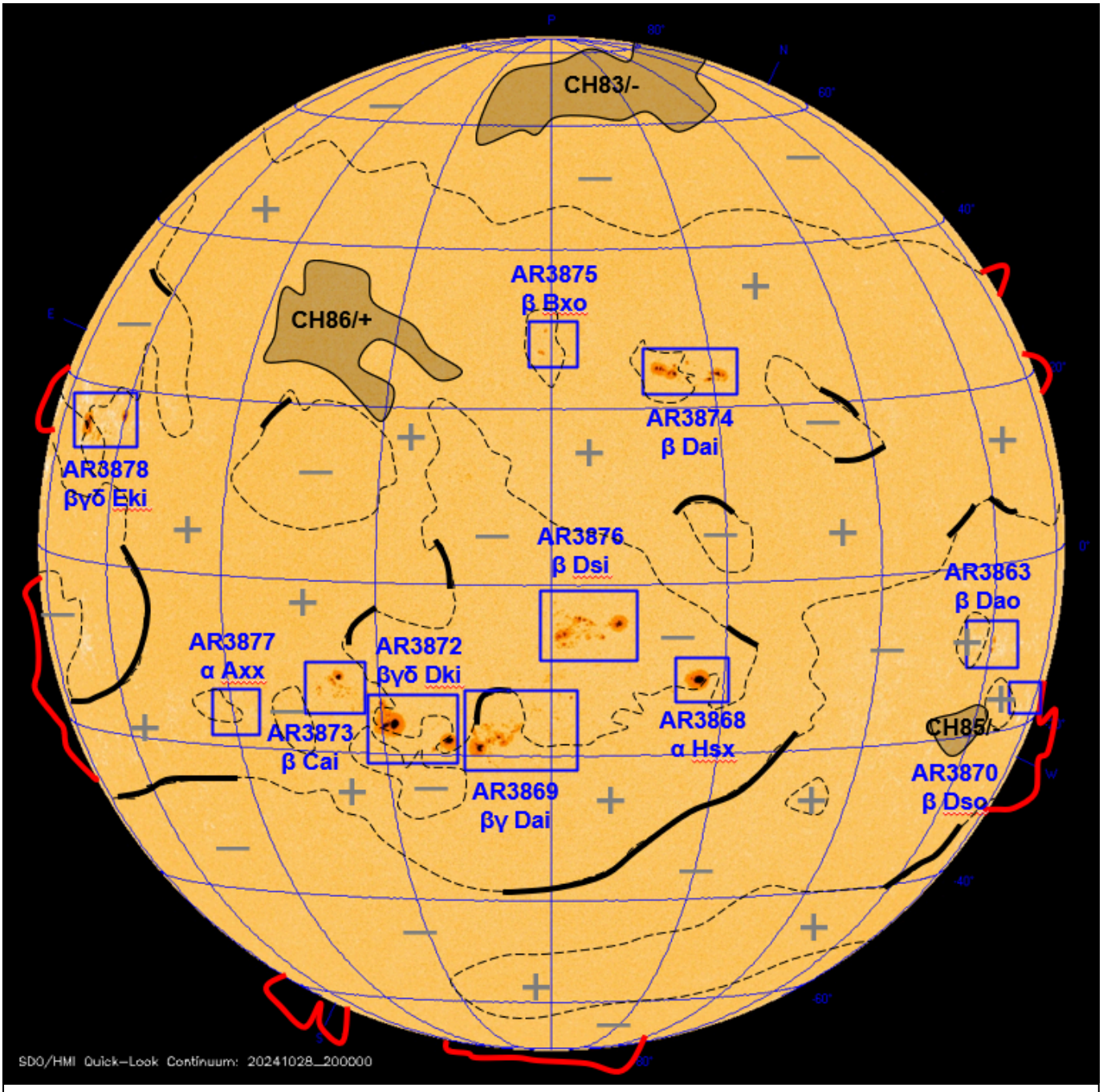
Figure 1: Solar Synoptic Map 28/2000 UTC



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

There are currently no Earth-directed CMEs.

Ongoing CME effects, from the arrival of the X1.8 flare early on 28 Oct are expected at first, with Elevated solar winds. This CME influence is expected to ease through day 1 (29 Oct), however slightly elevated solar winds will potentially continue with a small chance of ongoing enhancement from CH85/-. This is a small and indistinct feature, with any notable enhancement from feature is considered to be low confidence.

Geomagnetic activity is expected to ease to mostly Quiet, with isolated Unsettled spells from day 1 (29 Oct). However, given the location and history of the regions in the southeast disc, any further notable flares from these will have the potential to produce Earth-directed CMEs, and this geomagnetic forecast may change at short notice.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	5	5	5	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: L1 magnetometer data shows the arrival of the CME.

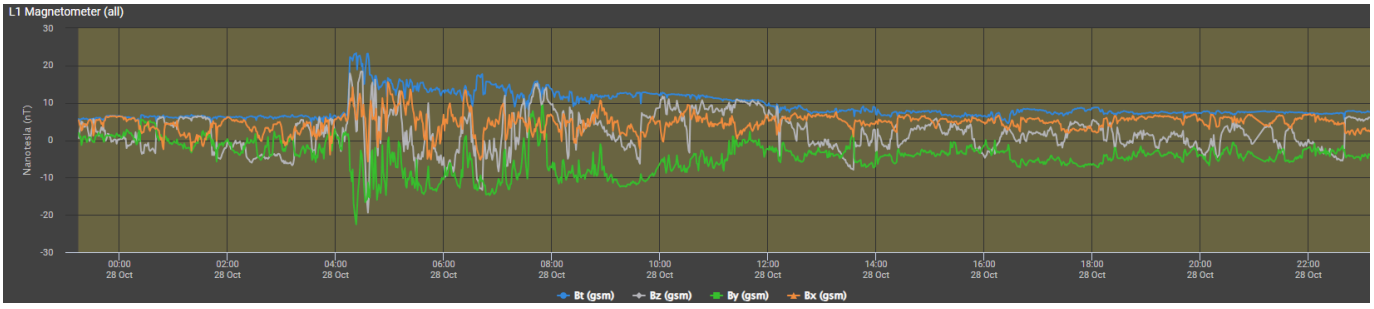

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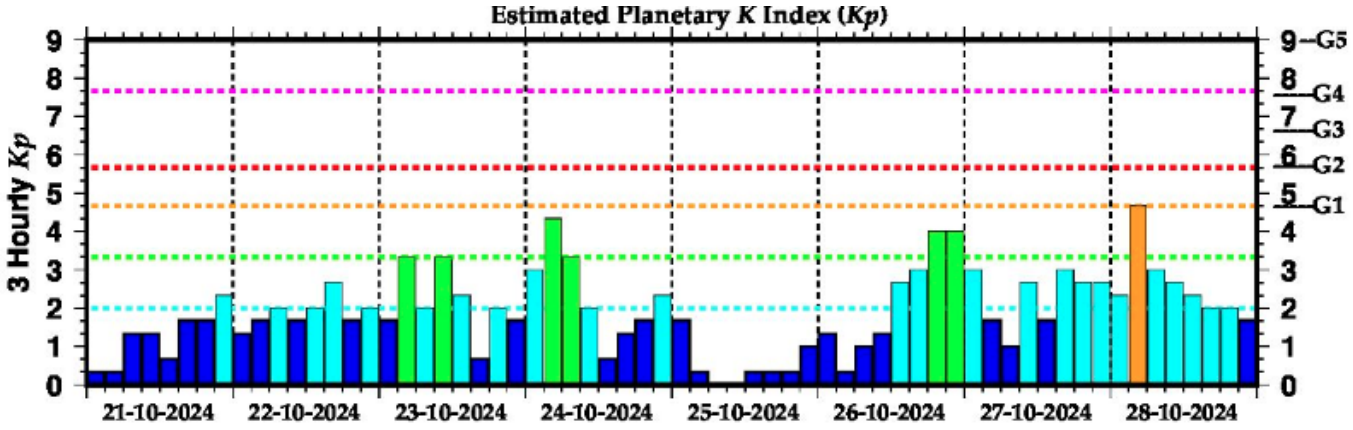
Figure 3: BGS Geomagnetic Activity



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Radio Blackouts - X-Ray Flares

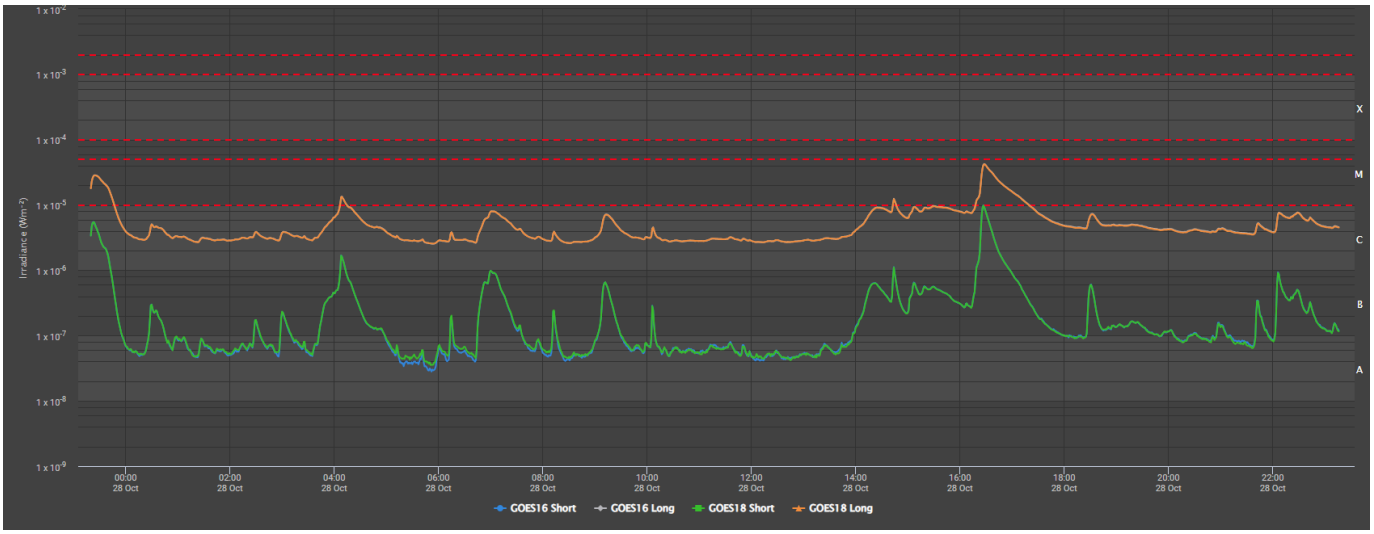
Moderate to High activity is expected, with further M-class flares and a chance of isolated X-class flares, given the complexity and number of regions on the disc.

There are eleven sunspot regions currently on the disc. AR3872 is the most complex, and central of the regions in the relatively congested southeast quadrant, with AR3873 to the east and AR3869 to the west of it. This region has a clear, albeit relatively weak delta spot on the northern edge of its main spot, and this delta-spot is gradually moving west relative to the main trailer, potentially increasing the shear across the region. AR3869 has seen its positive leader spots decay to become a collection of small spots, while AR3873 has seen nearly all positive leader spots fade. However, these regions remain complexity in terms of their magnetic structure on SDO imagery and have a history of X-class flares.

Elsewhere on the disc, the main flare risk comes from AR3878 near the northeast limb. This is difficult to assess, however the trailer is now showing a likely strong, albeit rather small delta spot. AR3876, now in the south centre disc is also of note, having developed fairly rapidly in the previous 24 hours, but is now showing signs of slowly maturing with some consolidation of its small spots. The other regions are smaller and simpler.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	Yes	80	80	80	80
Very Active	R3-R5 (X Class)	No	20	20	20	20

Figure 4: GOES-16/18 X-ray Flux



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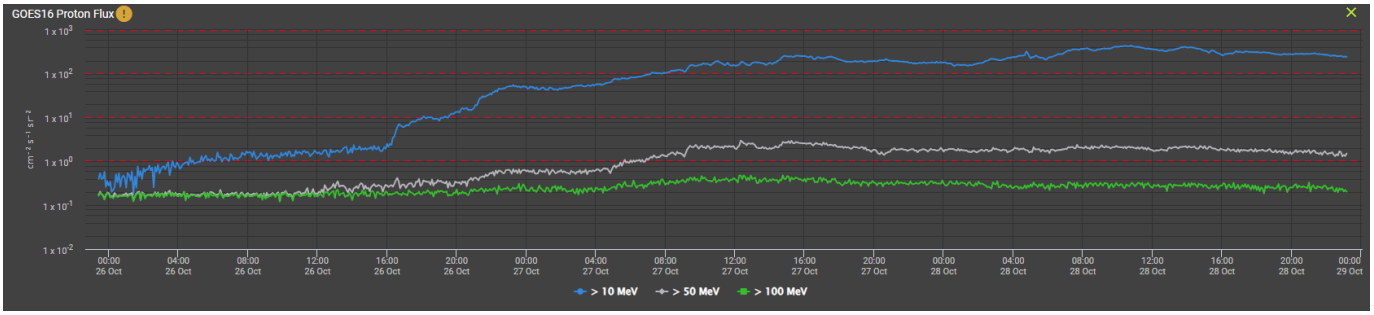
Solar Radiation Storms (High Energy Protons)

High energy proton flux at GOES-18 has persisted at S2 Moderate Radiation Storm. While the anticipated CME arrival has occurred, this was a weaker than anticipated impact and has not resulted in the subsequent forecast reduction in observed flux. A more gradual decay is now expected, likely persisting above the S1 level on day 1, and potentially day 2 (29-30 Oct).

However, given their increasingly geoeffective location and the history of proton productive flares, any further significant flares from the southeast disc has the potential to give further proton enhancement.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	Yes	99	50	30	10
Very Active	**≥ S3 ***	No	5	5	5	5
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 5: GOES-18 >10Mev >50MeV and >100 MeV Proton Flux over the last 72 hours.



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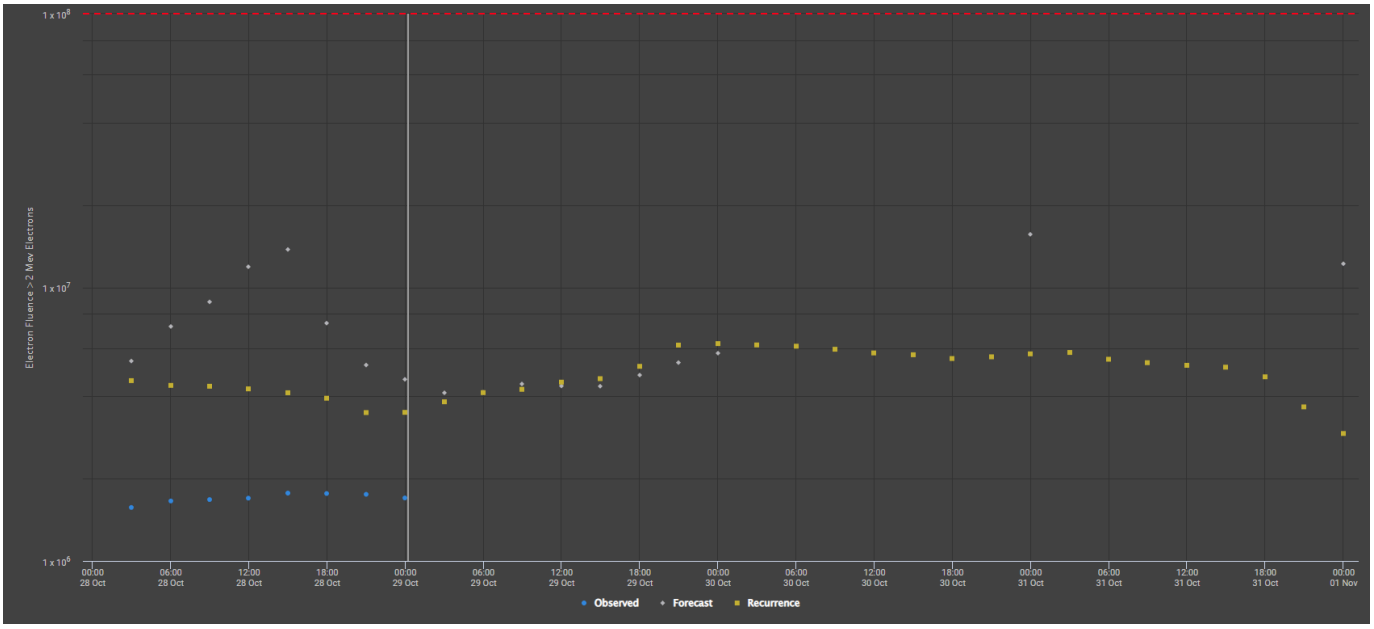
High Energy Electrons (≥ 2MeV)

High energy electron flux (greater than 2MeV) as observed by GOES16 is currently at background and expected to remain at this level. The CME arrival early on the 28 Oct was weaker than originally anticipated, and any impact on the radiation belts from this is likely to be limited. As solar winds ease, there is chance of for spells of Moderate flux, however this is low confidence.

The associated 24-hour fluence is currently expected to remain well below Active throughout the period, with the MOSWOC REFM forecast though to be providing reasonable guidance to the overall trend, although this is likely to over-estimate the forecast fluence due to the current elevated winds.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	1	1	1	1
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

Figure 6: GOES-16 >2 MeV 24hr Electron Fluence with REFM and Recurrence.



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